ERROR SPECTRUM OF HIGH TEMPORAL RESOLUTION GLOBAL POSITIONING SYSTEM MEASUREMENTS OF CRUSTAL STRAIN

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High resolution Global Positioning System (GPS) measurements, of the order of 10^{-8} or better, are of interest for monitoring preseismic and postseismic deformation. This study suggests there is an upper bound on the sample. rate of high temporal resolution GPS geodetic estimates beyond which unmodeled errors associated with ambient short period atmospheric variability are evidenced. This may limit the ability to observe short term small-scale crustal deformation.

Three-component station positions are modeled as white noise processes; each position estimate is assumed independent, Kalman filter estimates with sample rates of 1 min over a 24 hr span for a 11 km baseline from Vandenberg to the Harvest offshore platform, and 2 min over 5 continuous days for a 171 km baseline from Pinyon Flat Observatory to Pasadena (JPL), consistently yield few millimeter errors. Time series of baseline component estimates are representative of those which would be provided by a near-real-time, continuously operating GPS fault or volcanic monitoring network.

Spectral analysis of such stochastic baseline estimates indicates mismodeling which is not apparent in the time domain. Power spectral density (PSD) envelopes suggest white noise behavior only from the lowest frequency (inverse of the time series length) up to a corner frequency, beyond which the frequency fall-offs range from -1.6 to -2.6. This is attributed to the correlation of station position estimates with short-period tropospheric path delay (TPD) variability over large to small scales. TPDs in the Kalman filtering are modeled as a random walk process, whose -2 frequency fall-off approximates the power-law behavior expected from Kolmogorov atmospheric turbulence models.

Results suggest that station position frequency components beyond an observed corner are corrupted by TPD errors, with a dependence on baseline length. Increasing the random walk process noise preferentially increases observed TPD power at the lower frequencies, which tends to increase the baseline estimate PSD corner frequency, and decreases the baseline time series variance. Error spectra will be shown, with implications for the design, operation and expectations of GPS strain monitoring networks.